Flood and coastal zone management and protection measures

technical workshop Deltaic Soils 10-12 July 2006:

Developement of a reconstruction plan in the Netherlands: ‘

GeoDelft

reconstruction plan “Nederlek"

Outline:

- **GeoDelft**
- **results “Toetsing” primary dikes Netherlands**
- **Failure mechnisms**
- **Case “Nederlek”**
  - project team, procedures, “MER”
  - Technical challenges
  - Optimalisation, riskreduction: Innovation
- **Innovations (Cost and risk reduction)**
- **Shared oppertunities**

GeoDelft:

- **Founded in 1934**
- **Grand Technological Institute (GTI): geotechnical engineering**
- **Non profit organisation**
- **role is to obtain, generate and distribute geotechnical knowlegde**
- **Partnerships: RWS, Waterboards, etc.**

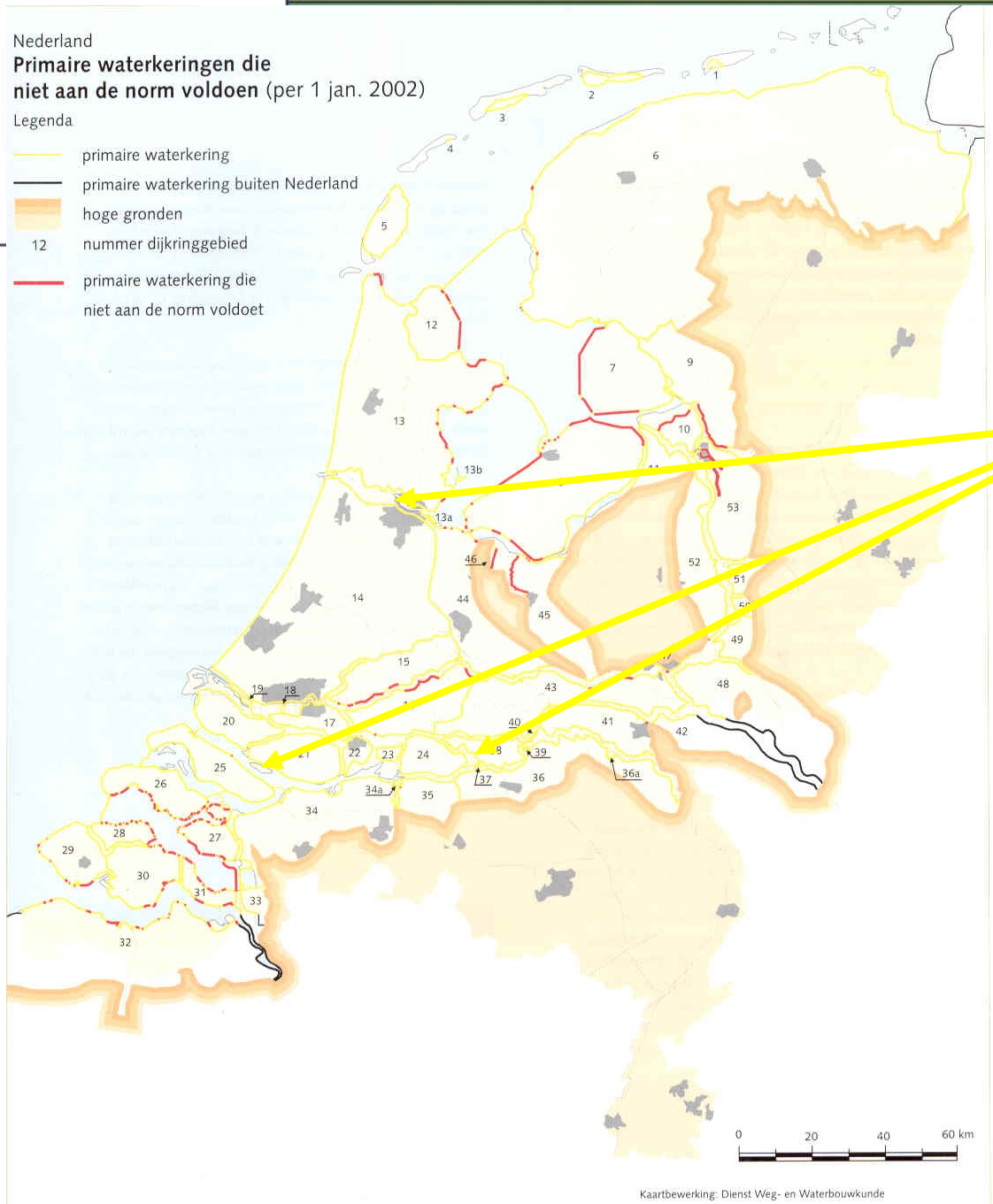
reconstruction plan “Nederlek"

results “Toetsing”(review) primary dikes Netherlands:

- Every 5 years “Toetsing” (review)
- Results 2001: 15% of 3,500 km: insufficient height/stability
- dike reinforcement

reconstruction plan “Nederle

results “Toetsing”(review) primary dikes Netherlands:


Nederland
Primaire waterkeringen die niet aan de norm voldoen (per 1 jan. 2002)
Legenda
primaire waterkering
primaire waterkering buiten Nederland
hoge gronden
12 nummer dijkringgebied
primaire waterkering die niet aan de norm voldoet
0 20 40 60 km
Kaartbewerking: Dienst Weg- en Waterbouwkunde

reconstruction plan “Nederle
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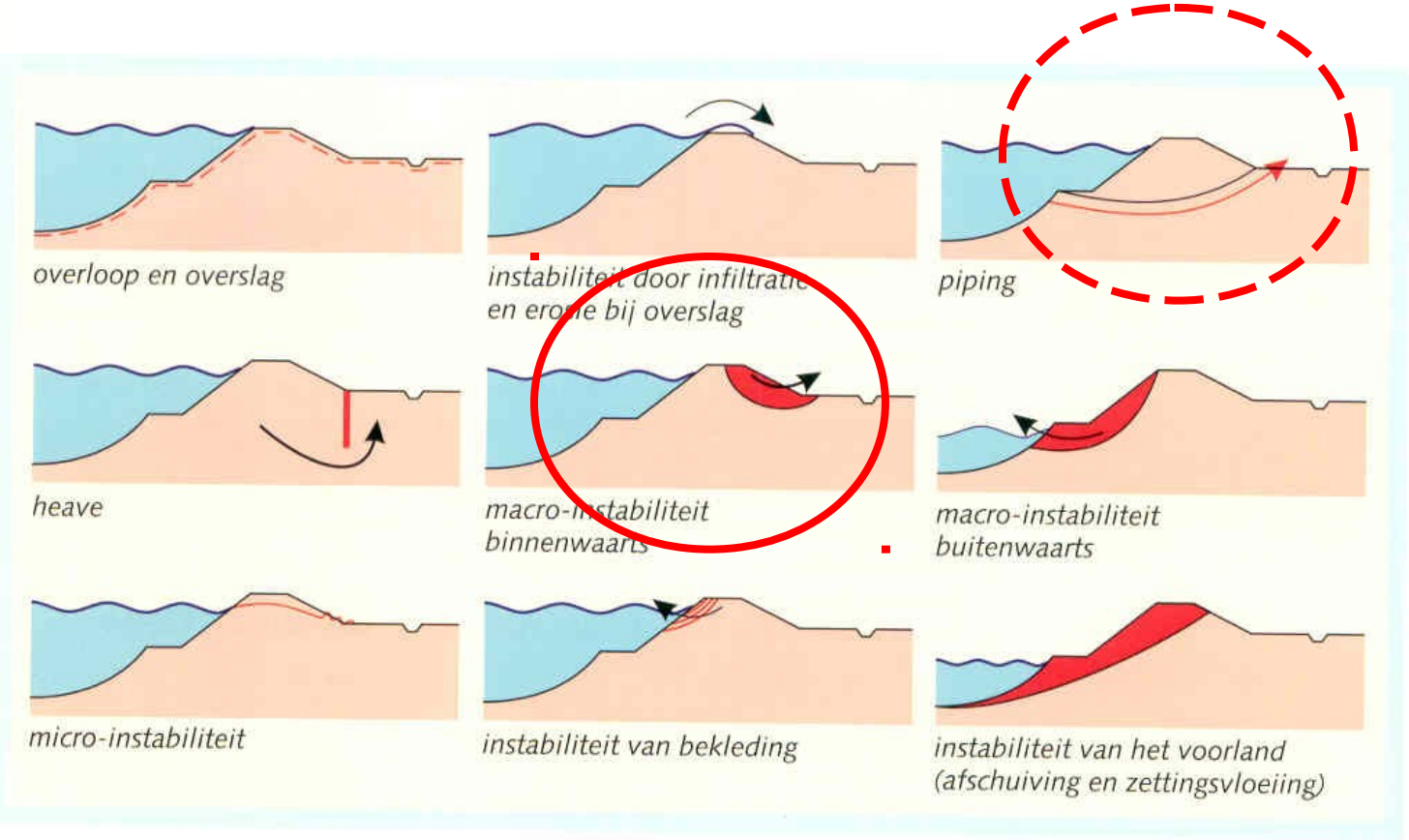
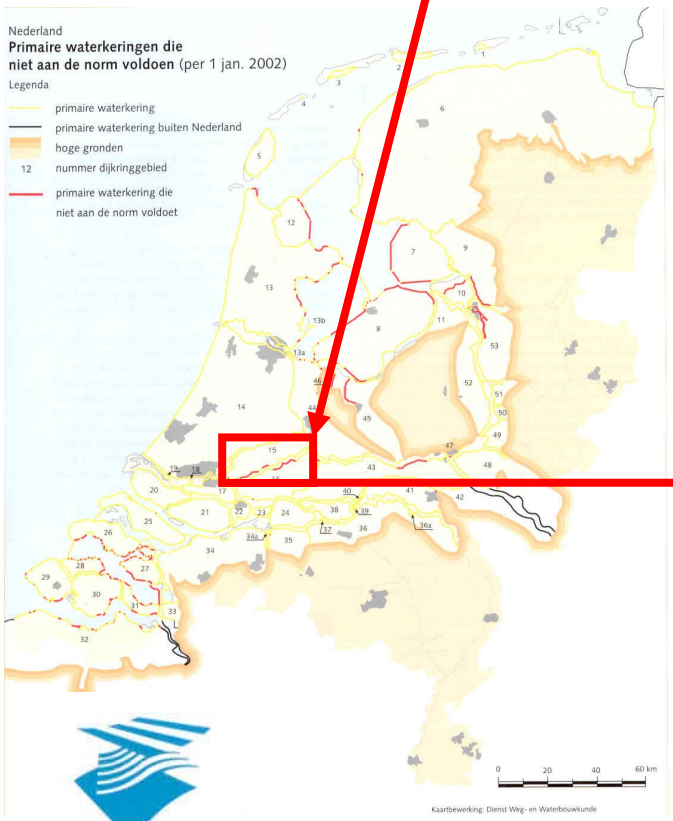
Failure mechanisms:



reconstruction plan “Nederlek”

Case “Nederlek” and “Bergambacht-Schoonhoven”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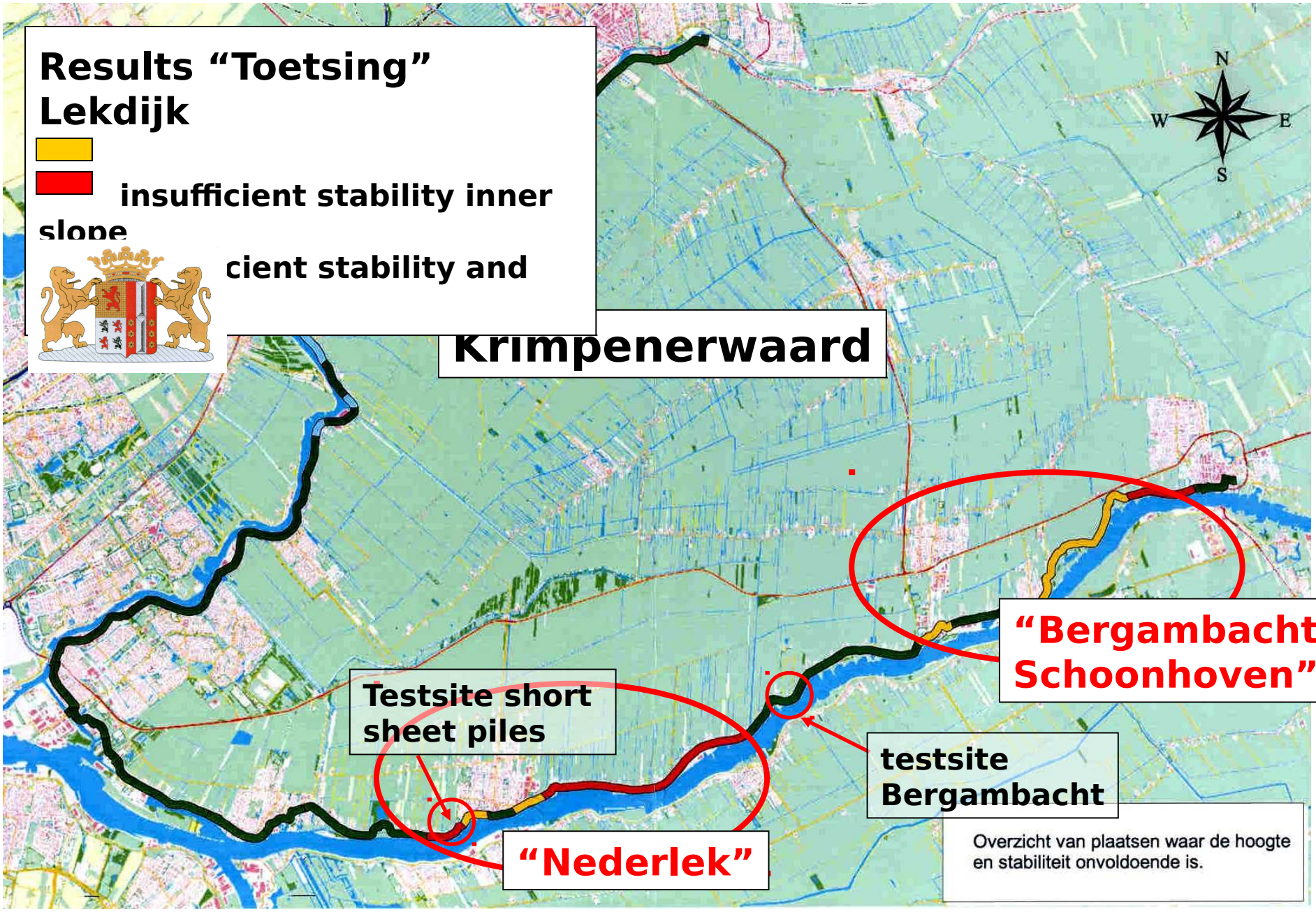
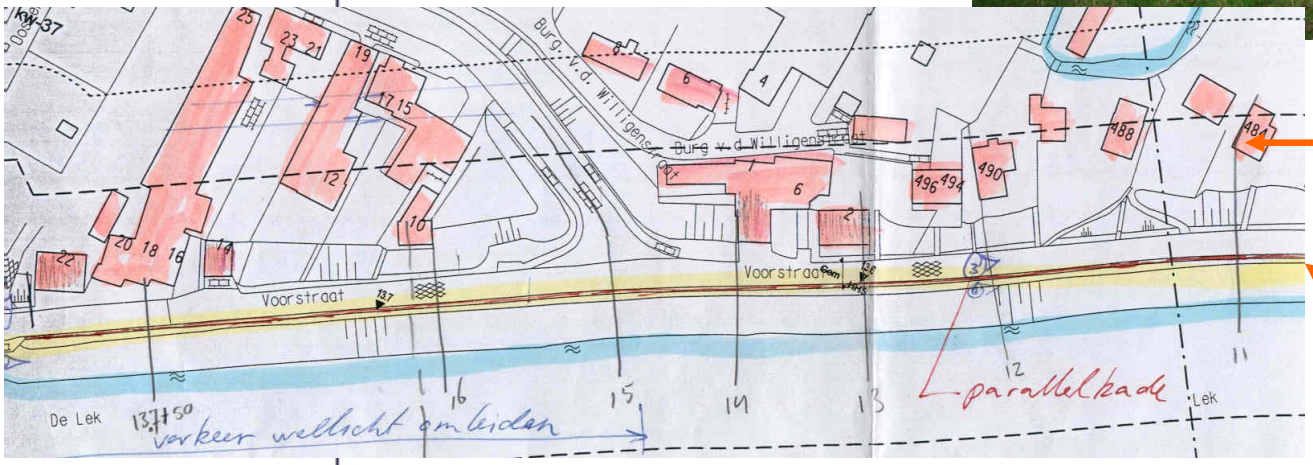
Next slide


Results “Toetsing” Lekdijk
insufficient stability inner slope
cient stability and
Krimpenerwaard
N
W
E
S
“Bergambacht-Schoonhoven”
Testsite short sheet piles
testsite Bergambacht
“Nederlek”
Overzicht van plaatsen waar de hoogte en stabiliteit onvoldoende is.

Case “Nederlek”

reconstruction plan “Nederlek"



Buildings / houses

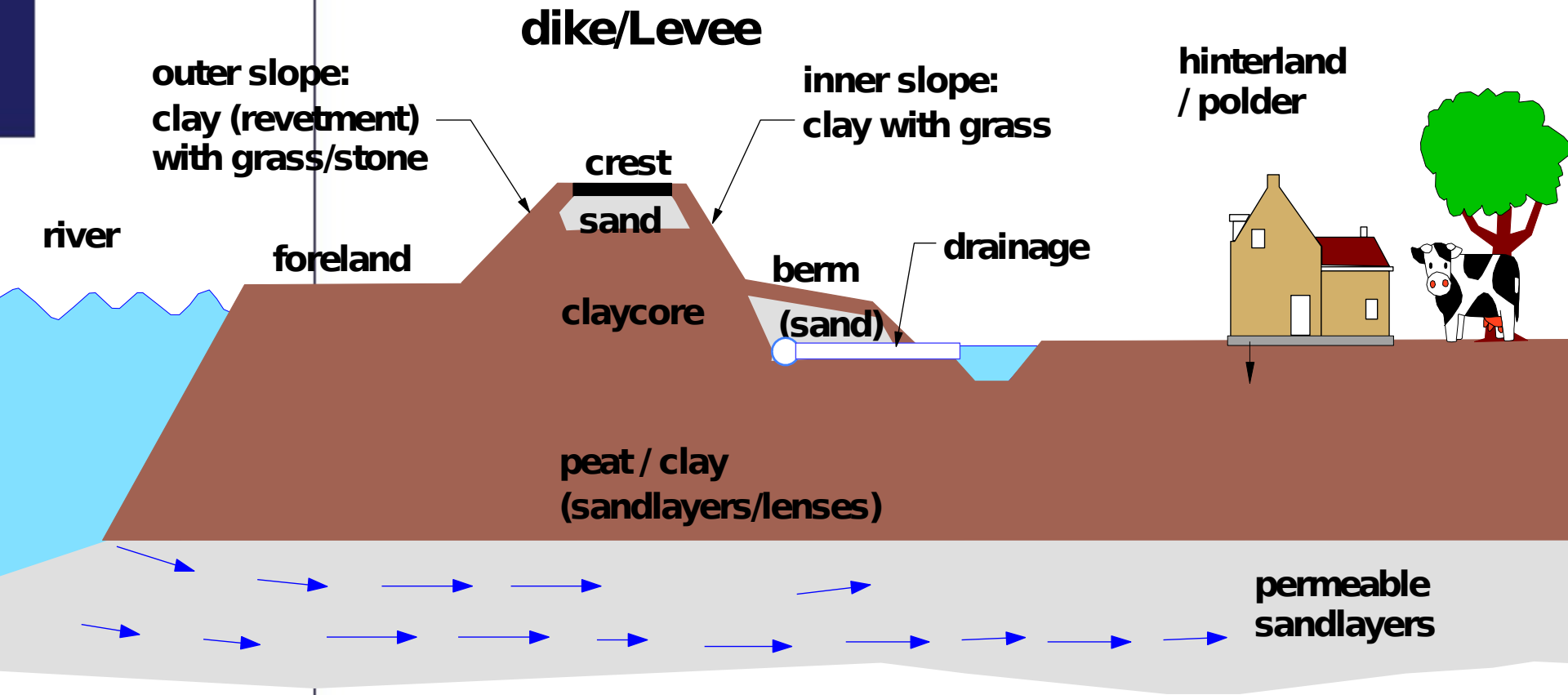
Dike / Levee

Reconstruction plan “Nederlek”

- **Dike alignment 5,5 km**
- **Project team: Waterboard, RWS, engineering consultant, GeoDelft, (inhabitants,..)**
  - Role GeoDelft. Responsible for all geotechnical aspects
- **peparations started in 2001:**
  - Soil investigation
  - MER-report; first choice alternative
  - Calculations for design
  - Calculations for execution reconstruction plan
  - Tender specifications
  - execution reconstruction plan

reconstruction plan “Nederlek"

Typical Dutch riverdike in Zuid-Holland



reconstruction plan “Nederle
k”

Slope stability with uplift

riverdike at streefkerk oktober 1984

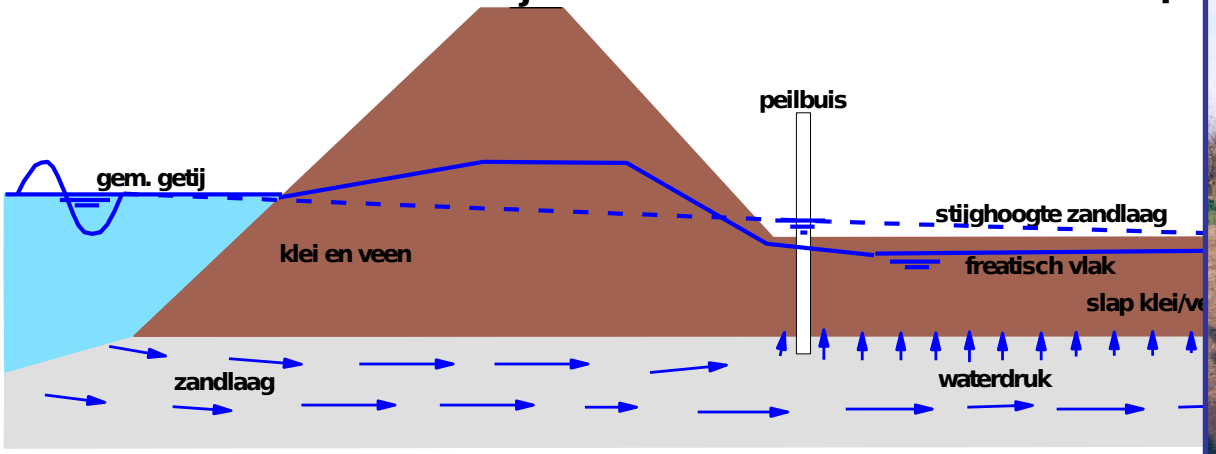
22 oktober 1984 om 10 uur

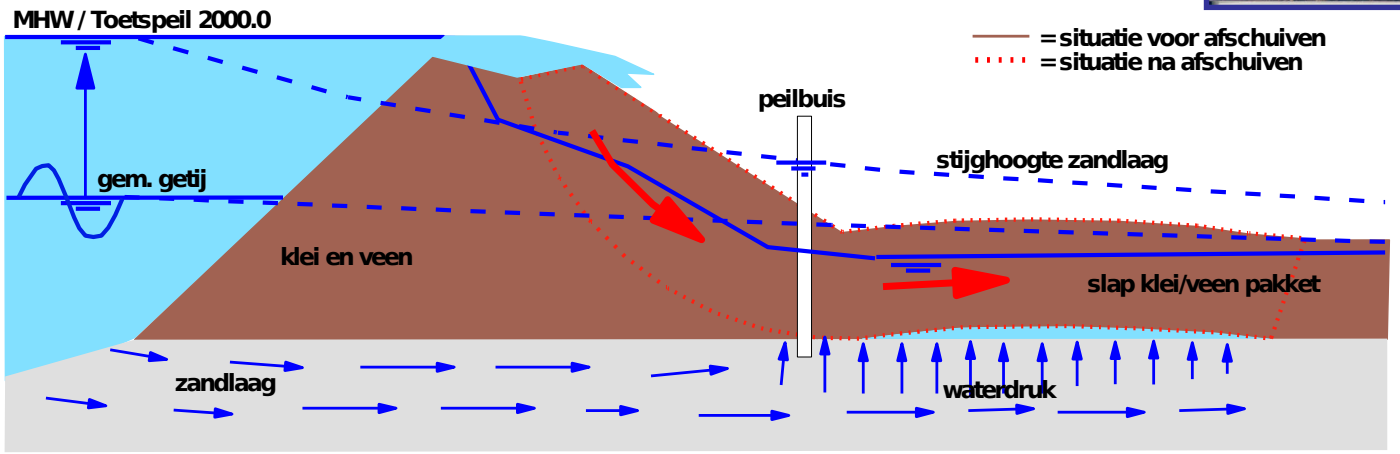
22 oktober 1984 om 16 uur

24 oktober 1984 om 16 uur

Slope stability with uplift

reconstruction
plan “Nederle
k”





reconstruction plan “Nederle
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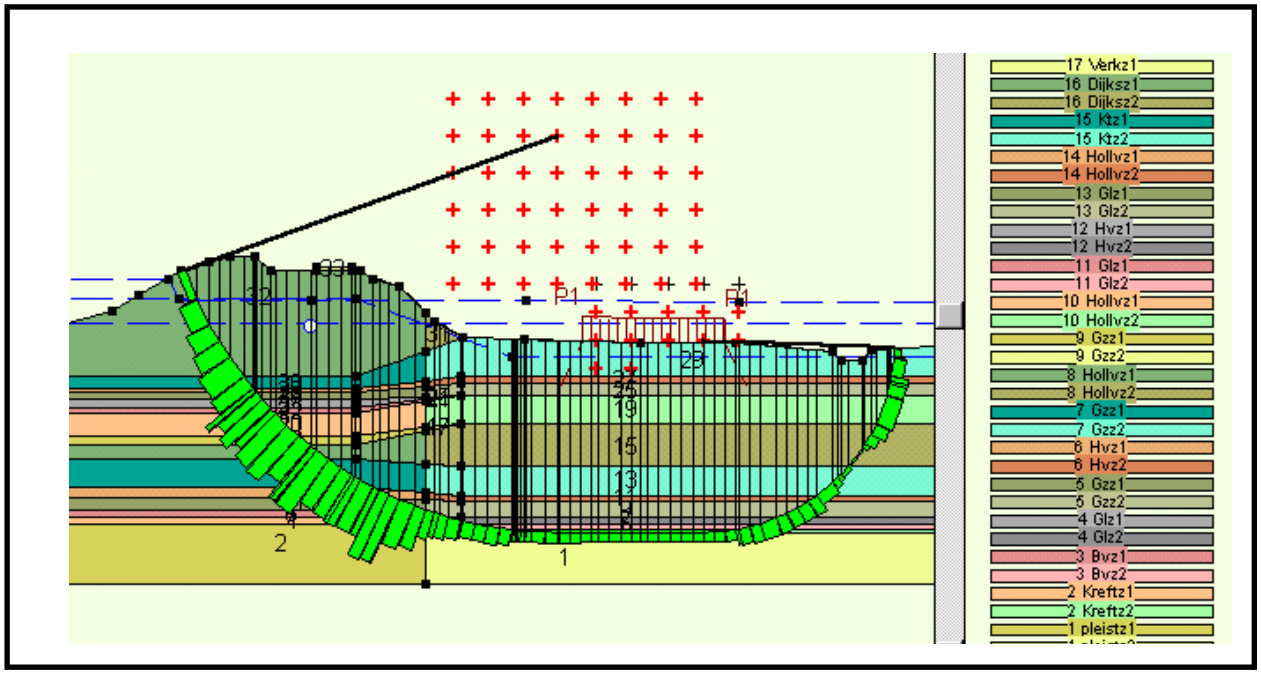
Slope stability with uplift

- **Model LiftVan**



reconstruction
plan “Nederle

Test site at Bergambacht

Oude Dijk

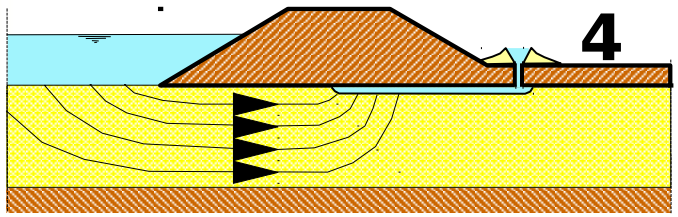
Test site

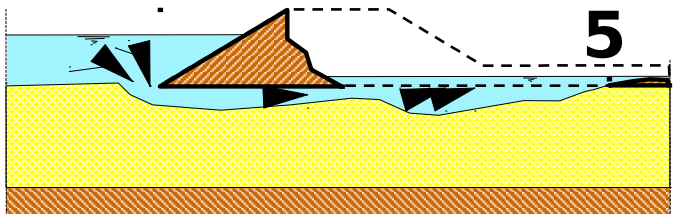
Old dike

New dike

reconstruction plan “Nederlek"

Piping (sand boils):

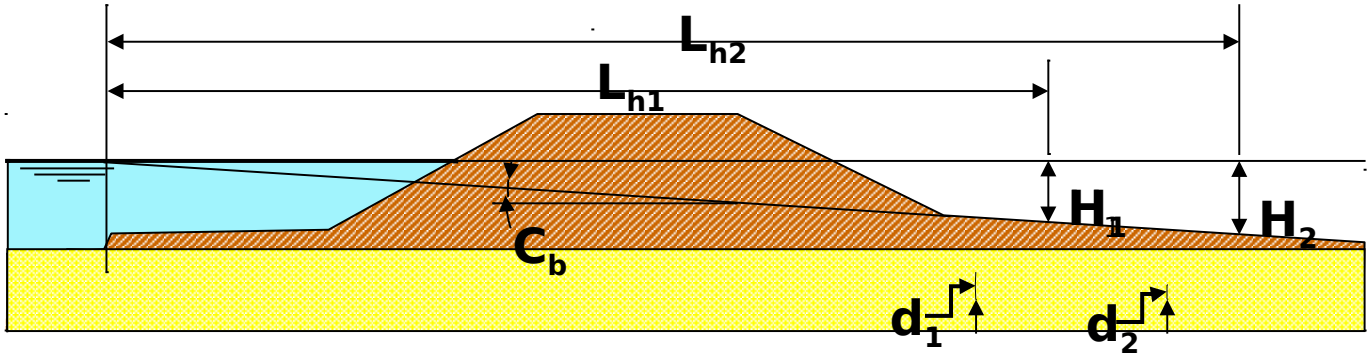




Sand boils

reconstruction plan “Nederlek"

Piping: Methods



- **Bligh**

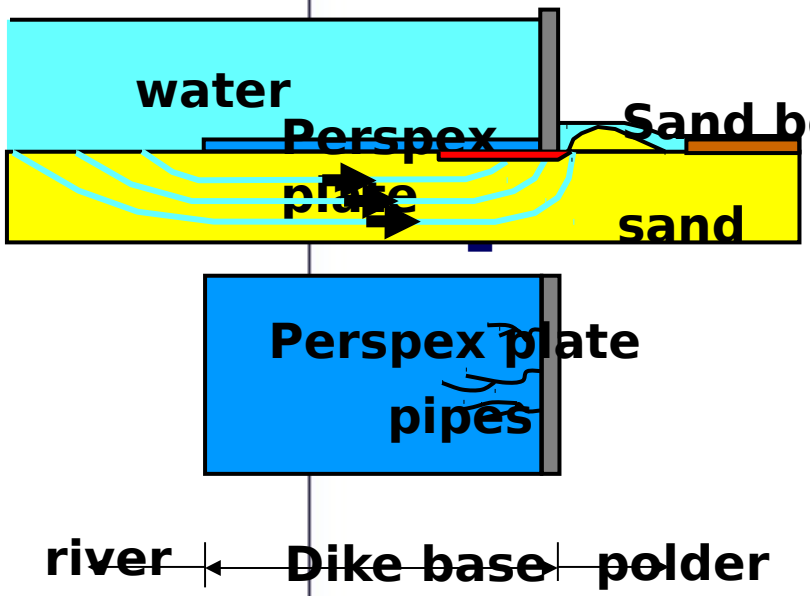
$$H - 0{,}3d = \frac{L_h}{C_b} \qquad (C_b = 12 \text{ à } 18)$$

$$L_h = C_b (H - 0{,}3d)$$

- **Sellmeijer**

$$H - 0{,}3d = a\, c\, \frac{\rho_p}{\rho_w} \tan(\theta)\,(0.6 - 0.1 \ln(c))\, L$$

Piping: Sellmeijer method



Verification tests few years ago.

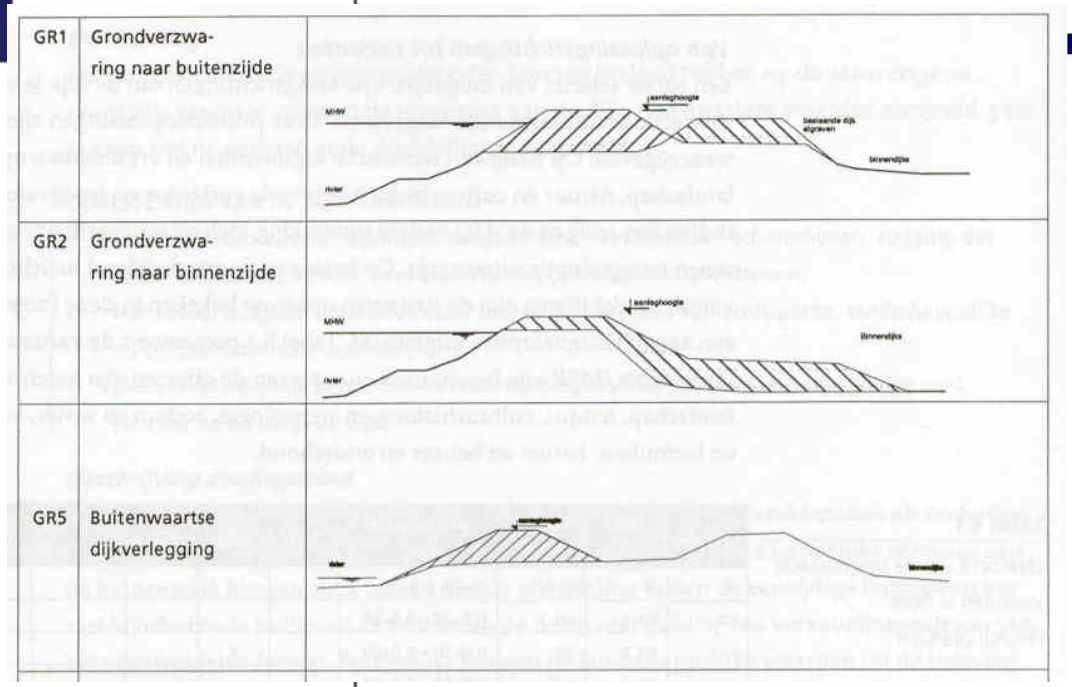
New developements last year and now:

Method takes into account:

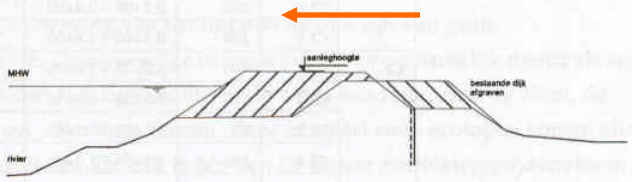
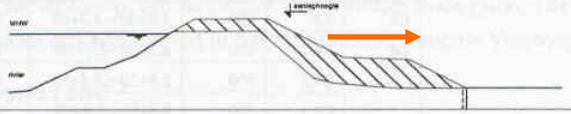
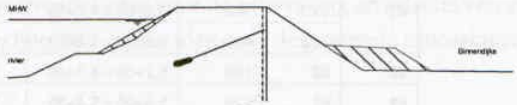
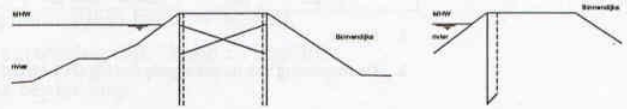
- **Grain size sand and distribution**
- **Thickness sand en clay layer(s) and slope (subsoil geometry)**
- **Permeability sandlayer(s) (more than one)**
- **……..**

reconstruction plan “Nederlek"

Back to case “Nederlek”



- **slope instability with uplift: berms upto 30m, with height upto 3m (k€/m 0.5 – 2)**

CO1	Licht/middel zwaar damwand-scherm in combinatie met grond	
CO2	Licht/middel zwaar damwand-scherm in combinatie met binnenwaartse grondoplossing	
CO3	Constructieve damwand, eventueel in combinatie met taludverflauw-ing en/of asverschuiving van 0-5 meter	
CO4	Kistdam/ diepwand/ betonnen keerwand (hiernaast afgebeeld respectievelijk de kistdam en een diepwand)	

Buildings: lack of space:

- **Soil with construction (sheet pile wall) (k€/m 1.5 – 4)**
- **Anchored sheet-piling (k€/m 3-6)**
- **Cofferdams (k€/m 6 – 10)**
- **Bored piles (concrete wall) (k€/m 6 – 10)**

Total reconstruction costs very high

reconstruction plan “Nederlek"

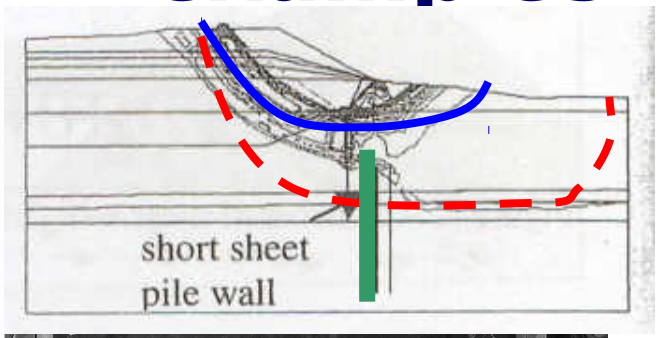
Innovations:

- **Cost reduction, risk reduction**
- **Mission GeoDelft: obtain, generate and distribute geotechnical knowlegde:**
  &
  GeoDelft involved in project
  &
  co-operation RWS DWW, engineering consultants, …..
  =
  innovations
- **Implementation in projects and distribute knowlegde**

reconstruction plan "Nederlek"

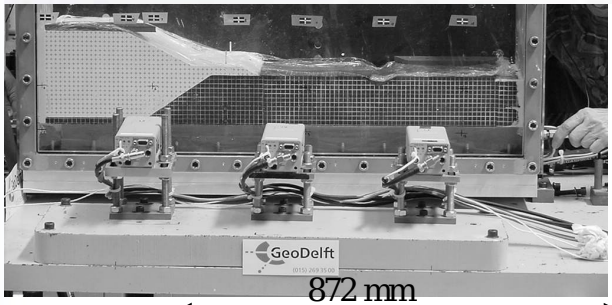
Innovations (Nederlek): examples

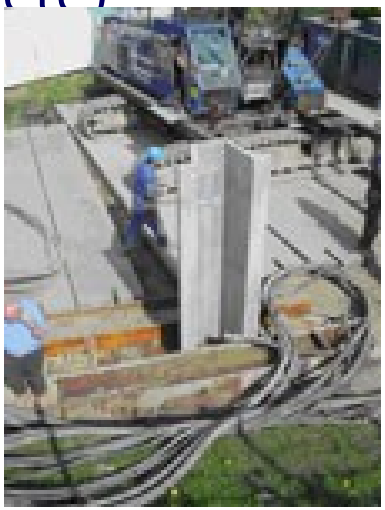
Modelling (Plaxis)



- **Short sheet-piling** (cost reduction € 500-1000 /m)
- (concrete sheet-piling: HSZVB-concrete)

Centrifuge testing

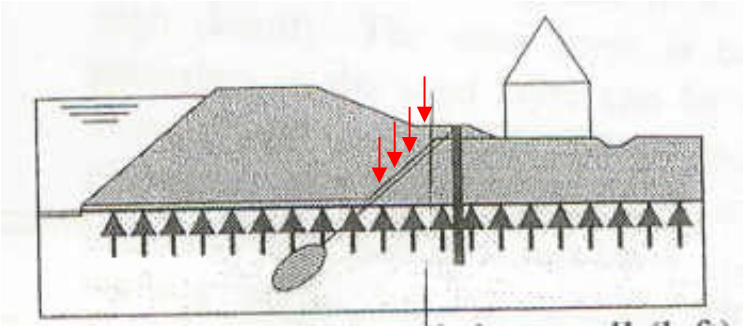




prototype experiments (installation)

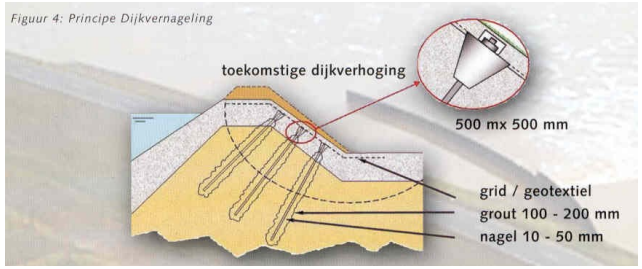
Innovations (Nederlek): examples (2)

- **Research for optimalisation anchor forces through settlement on anchors rods** (Anchored sheet-piling)
- …..

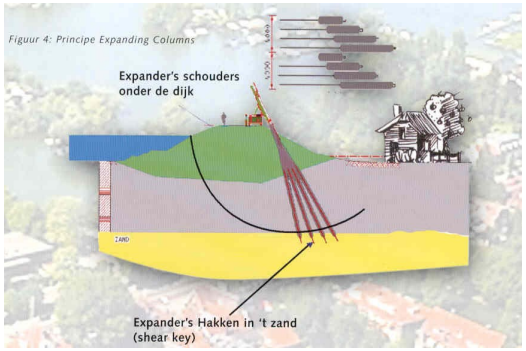


reconstruction plan “Nederlek”

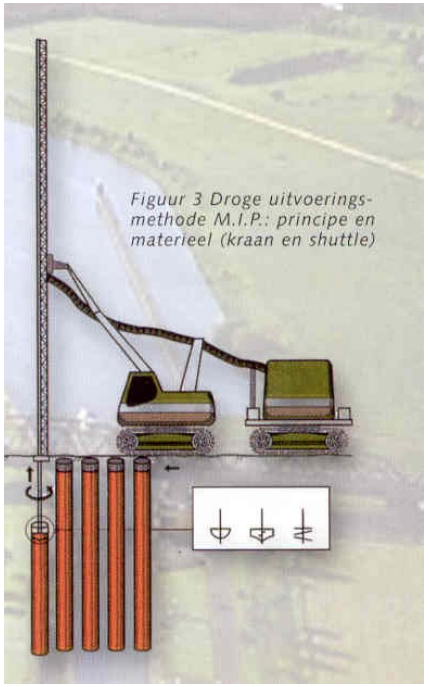
Other innovations in the Netherlands:



Dike nailing



Expanding columns



Mixed in Place (MIP)

reconstruction plan “Nederle k"

Shared oppertunities:

- **Sharing the same issues?** (failure mechnisms / soft soils)
- **Usefull innovations?**
- **Research programms => joint research?:**
  - VNK / Succes: Safety against Flooding (hydraulic load – failure mechanisms – concequences of flooding)
  - DAM: Dike Strength Module (support system for high water information system; flood risk management; fast answers during threat of flooding/disasters)
  - Modelling of subsoil in view of limited amount of information (RRD, geological input, geostatistics)
  - Smart Soils® (insitu modification of soil paramaters (micro-biology, pore space engineering))
  - Inside, short sheet pile: Space saving reinforcement techniques
  - Failure mechanisms /dike technology (stability with uplift, piping (sand boils), stability of inner slope in regard to overtopping, stability of peat dikes, erosion (residual strength and breaching)
  - Prototype experiments (Bergambacht, IJKDIJK, Ankeveen)
  - Centrifuge (200g) testing
  - Relation between deformation and failure (“actual strength” IJKDIJK)

reconstruction plan “Nederlek"

Questions?
Discussion ?